Commuter Ferry Wake in New York Harbor

Understanding the Problem and Some Strategies for Mitigation

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Objectives

- Describe the nature of project
- Discuss the fundamentals of wake formation
- Discuss how wake effects objects in the environment
- Offer suggestions on how to minimize impact of wake

Nature of Project: Research Background

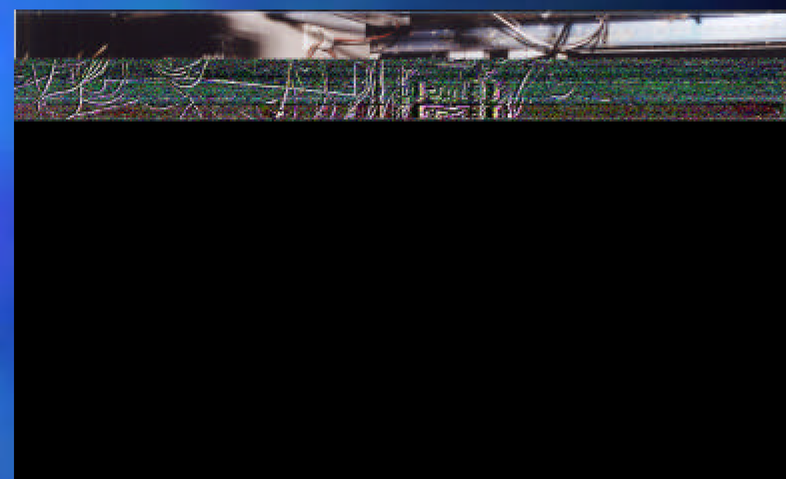
- Study Funding Provided by NJDOT
- Data collected in July of 2002
- Research performed by:
  - Brian Fullerton, M.Eng., Project Leader and field data collection
  - Raju Datla, PhD. Naval Architecture, Tank Testing

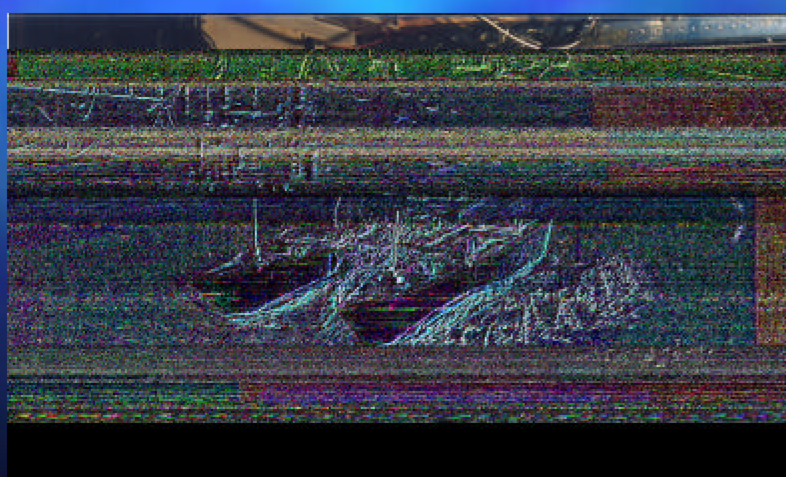
Nature of Project: Research Performed

- Tank Testing
  - Model tow testing
  - Speed and wave height
  - Various loadings and Cgs (trim)
- Field Data
  - Pressure record observations
  - Analysis

Nature of Project: Research Performed

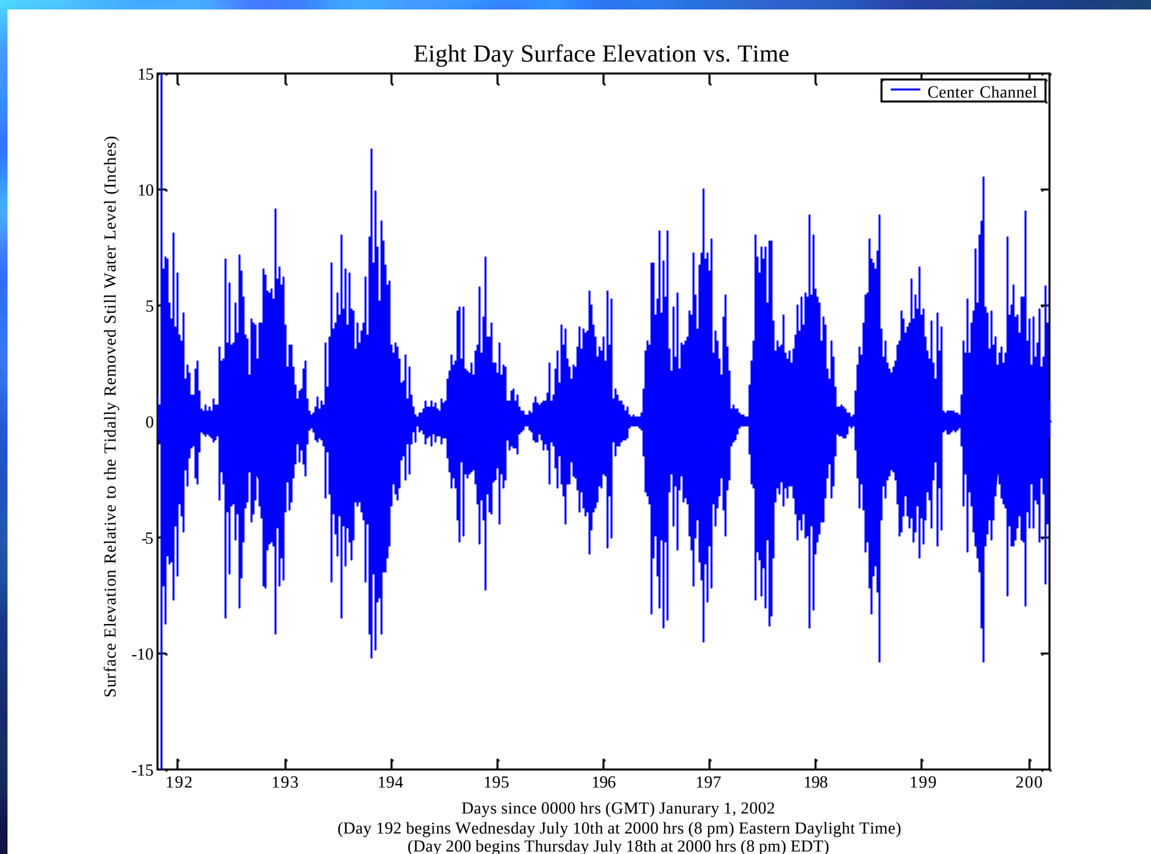
- Tank Tests
  - Scale Models
  - Wake measurements





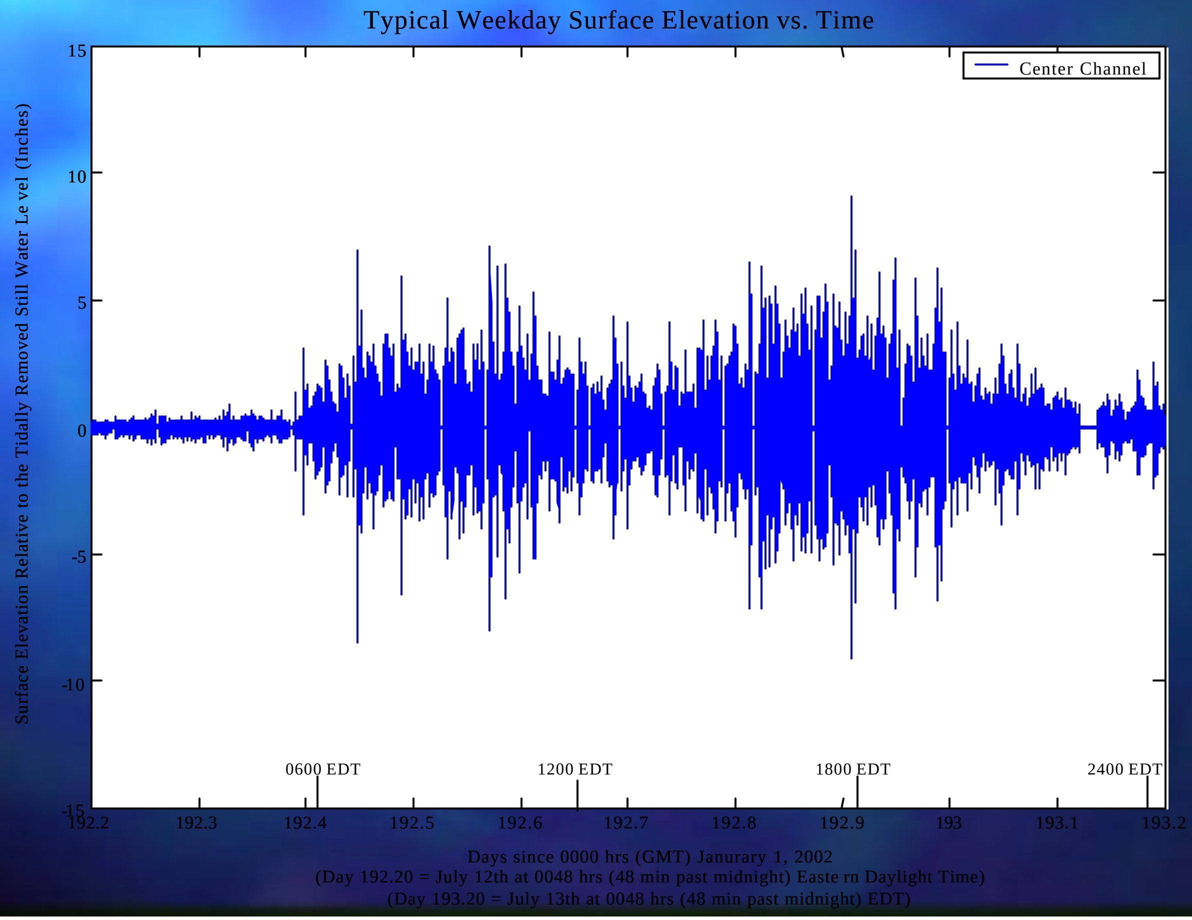
Nature of Project: Research Performed

- Field Data



Nature of Project: Research Performed

- Field Data



Wake Formation: Some Terms

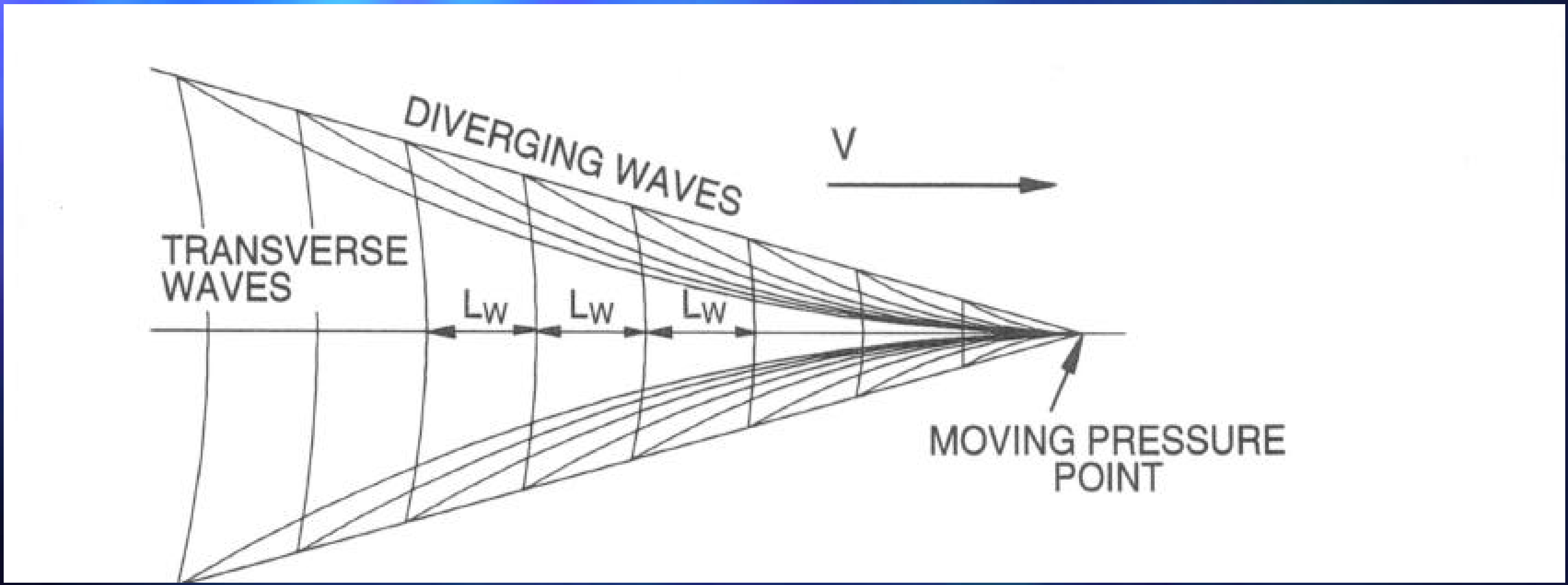
- Wake is caused by pressure differences along a vessels hull
- Wake is characterized by height
- Wake is also characterized by period
- While faster speeds will always result in longer period waves, the behavior of wake height is not as simple a relationship
- Together wave height and period give its power, and height affects power twice as much as period

Wake Formation: Hull Modes

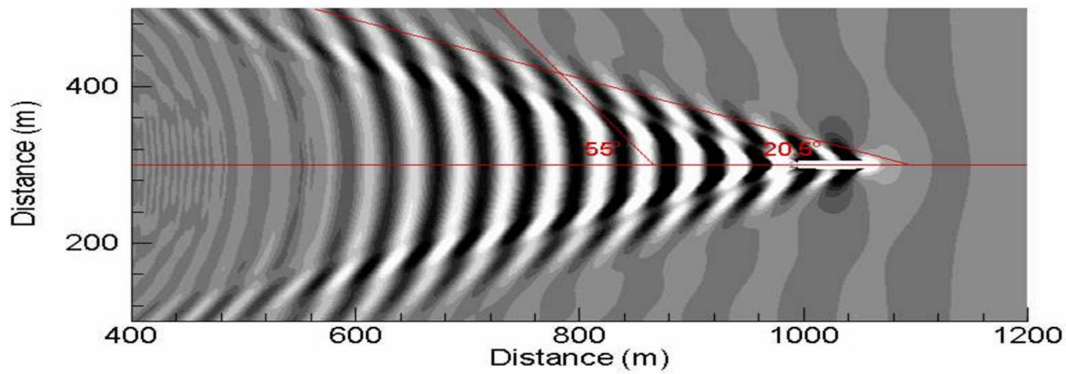
- Hulls operate in 2 distinct modes
  - Pure displacement (sailboat or tug or ferry at idle)
  - Pure planing (hydroplane or small speedboat or Sea Otter hooked up)
- Hulls also operate in the transition region between these two ideals (all vessels as they accelerate or decelerate)

Wake Formation: Direction of Travel

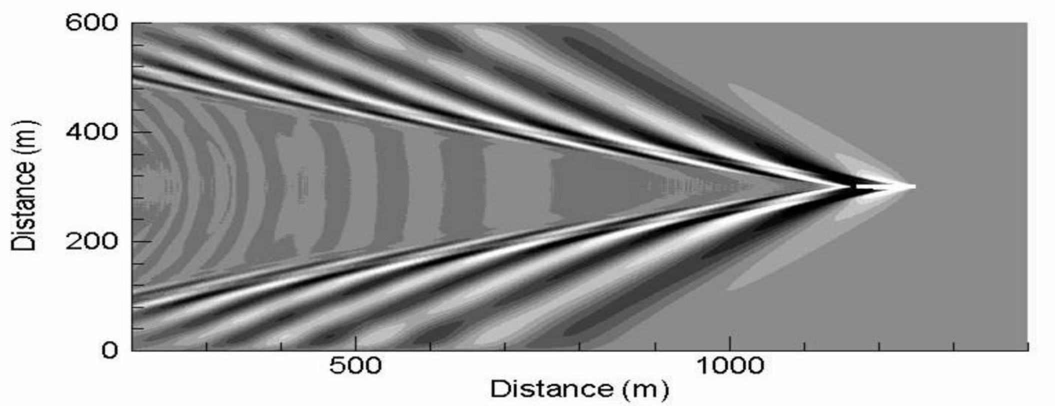
- Final important piece is angle of wave travel



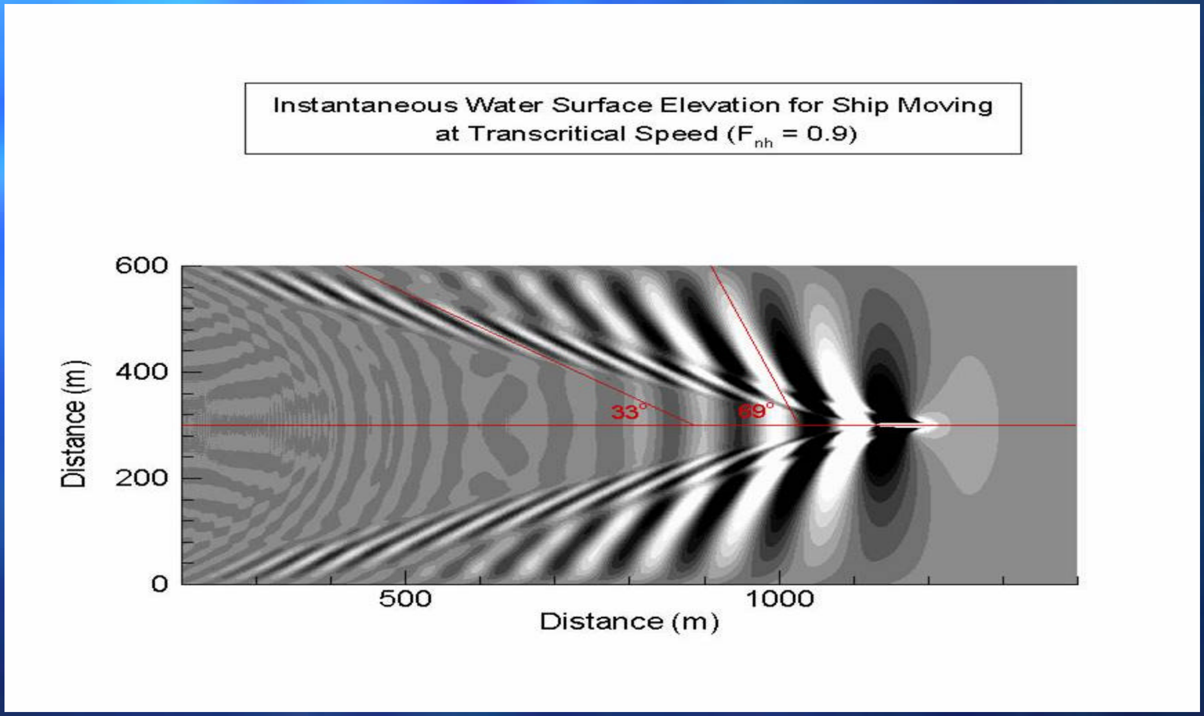
Instantaneous Water Surface Elevation for Ship Moving at Subcritical Speed (F_{nh} = 0.65)



Instantaneous Water Surface Elevation for Ship Moving at Supercritical Speed (F_{nh} = 1.5)



Wake Formation: Direction of Travel



Wake in the Environment

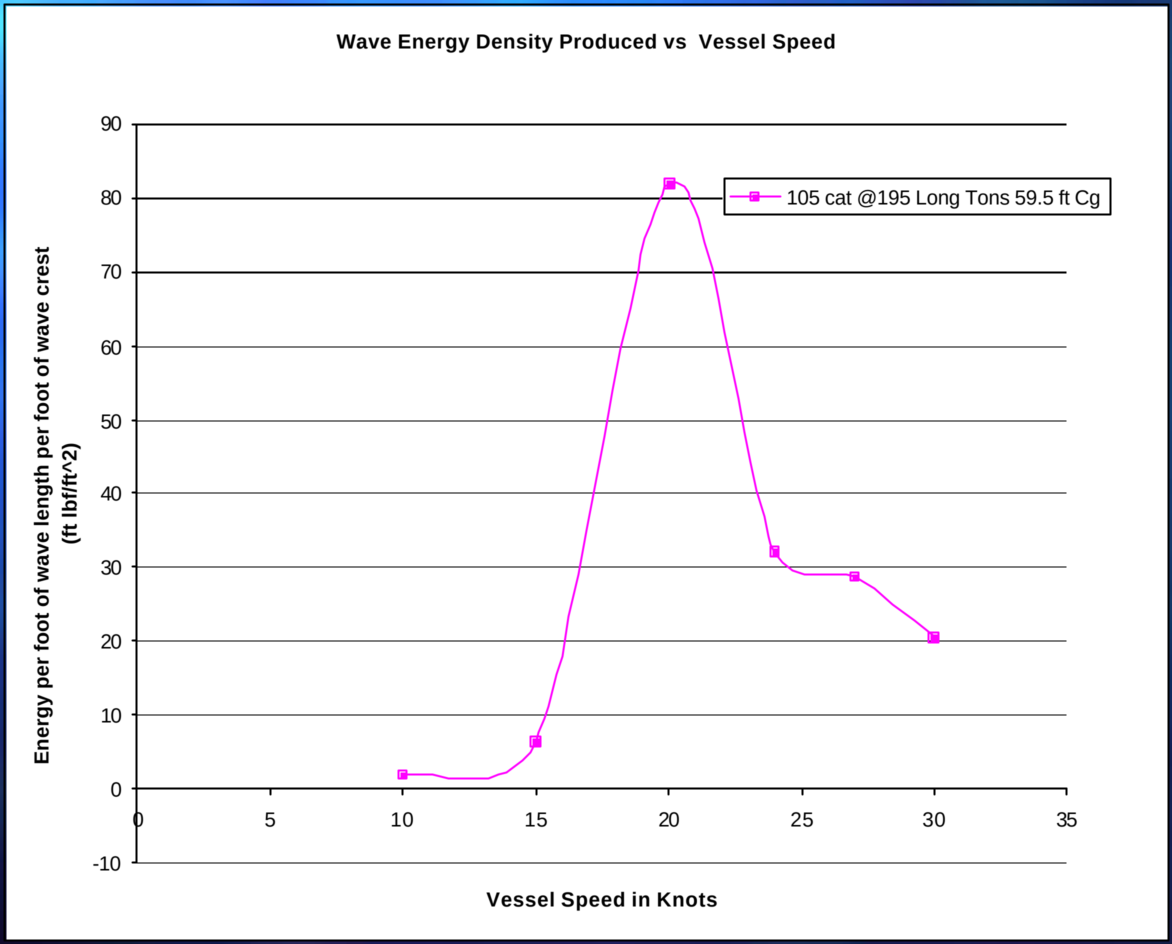
- Behaves like any other wave with similar characteristics
- Fixed structures / shorelines
  - Dissipative
  - Reflective
- Floating bodies react according to dimensions

Wake in the Environment

- Long waves become difficult to defend against: time is on the waves side
- Once a certain (period) threshold is reached, defense mechanisms quickly become ineffective
- However the longest wake produced by a hull occurs during an efficient mode (planing) and heights quickly diminish resulting in lower energy density

Wake in the Environment

- Back to the tank



Minimizing Impact

- Key wake characteristics
  - Height
  - Period
  - Direction of propagation
- Height is partially controlled by design
- Height is also controlled by speed as is period.
- Direction of propagation is controlled by speed and direction (remember angle of wave formation is a function of speed)

Minimizing Impact

- In a world without schedules a solution would be operate everywhere at idle
- This is not a real solution if a commuter ferry system is to exist
- In a world without traffic and with immediate transition to planing, a solution would be to operate at very high speeds for the entire trip
- This is not a real solution as transition is not instantaneous, and traffic makes this approach far from safe

Minimizing Impact

- We have to do the best we can
- Period threshold is reached early
  - Before 15 knots the wavelength is long enough to render most wave barriers ineffective, and falls between the minor and major characteristic lengths of most vessels and docks in the harbor
  - Speed control alone (unless extreme) can not do the job
- Send the biggest waves in a direction they will do the least damage

Minimizing Impact

- The best direction to send wake is away from whatever is sensitive
- Make transitions as short as possible and operate as far from critical speed as possible (rem. the peak of the graph)
- Distance helps but enough distance does not exist in the harbor to eliminate all effects. Use what you do have to your advantage.
- Remember that wake moves both sideways *and* forward.   Slowing to a crawl just before or alongside a sensitive area ensures the most energy into that area!

In Conclusion

- The best direction to send wake is away from whatever is sensitive
- Make transitions as short as possible and operate as far from critical speed as possible (rem. the peak of the graph)
- Distance helps but enough distance does not exist in the harbor to eliminate all effects. Use what you do have to your advantage.
- Remember that wake moves both sideways *and* forward. Slowing to a crawl just before or alongside a sensitive area ensures the most energy into that area!